METHOD OF MAKING A MATERIAL WEB BY HYDRODYNAMIC NEEDLING

CROSS REFERENCE TO RELATED APPLICATIONS

This application is the US national phase of PCT application PCT/EP2004/050402, filed 1 April 2004, published 21 October 2007 as WO 2004/090214, and claiming the priority of German patent application 10316259.3 itself filed 8 April 2003, whose entire disclosures are herewith incorporated by reference.

FIELD OF THE INVENTION

The invention relates to a nonwoven, woven or knitted fabric web consisting of metal fibers or filaments, which is to be stitch-bonded or finished.

The stitch-bonding of nonwovens made of textile fibers such as organic and inorganic materials and natural and synthetic polymers by means of the spunlace method is known where the fiber structure is subjected to a hydrodynamic needling.

Metal fibers are produced, for example, using the bundle cold-drawing method (US 3 379 000), a cutting method (shaving the rolled edge of a roll of metal foil according to US 4 930 199) or directly from a melt, for example, by extrusion, as described in U.S. Patent 5 524 704.

The formation of nonwovens from, for example, 100% metal fibers is currently carried out using mechanical methods of forming nonwovens using carding rollers, the aerodynamic nonwoven formation method and the wet nonwoven method and requires special know-how.

Disadvantages with the manufacture of slivers, combed yarns and carded yarns from metal fibers especially arise from the fact that a fraction of textile carrier fibers is absolutely essential to maintain the thread formation process. In this case, threads comprising homogeneous mixtures over the thread cross-section can be achieved but also the manufacture of multifilament cover yarns with metal fibers in the core and textile fibers in the sheath is known in practice.

The manufacture of fabrics from such filamentous structures is known, as is described for example in DE 699 01 941 (US 6,289,702). According to this, knitted fabrics are made of yarns having different metal fiber contents. In this case, in addition to the complex thread formation process, it is also necessary to use textile fiber materials to maintain the knitting process.

The stitch-bonding of aerodynamically formed nonwovens using the mechanical needling method is likewise known. Thus, the burner membrane described in DE 698 03 085 (US 6,607,998) contains at least one mechanically needled metal fiber layer. A disadvantage with mechanical needling, besides the discontinuous operating mode, is also the need to achieve a large minimum mass or thickness in order to be able to achieve a stitch-bonding effect.

A disadvantage with all these mechanical stitch-bonding methods, in addition to the afore-mentioned difficulties during the processing of metal fibers, is the high wear of the stitch-bonding elements such as knitting, felting needles etc. They must be replaced by new stitch-bonding elements after a short time of usage

as a result of which costs are additionally incurred for the material exposed to wear and the down times resulting from the exchange of worn parts cause the manufacturing costs of a stitch-bonded metal fiber nonwoven to increase.

OBJECT OF THE INVENTION

It is thus the object of the invention to provide a nonwoven during the manufacture of which the complex laborious and time-consuming thread formation process can be bypassed, material webs comprising preferably 100% metal fibers without any textile carrier fibers can be used, at least in part, the wear of stitch-bonding elements is reduced or completely eliminated and thin fabrics having a high pore volume but with small pore sizes can be achieved.

SUMMARY OF THE INVENTION

This object is solved by the fact that a material web consisting, at least in part, of metal fibers or metal filaments is stitch-bonded and/or finished by means of high-energy water jets to form a material web ready for use such as cloth or the like.

As a result of the progress made in the refinement of metal fibers on the one hand and as a result of the improvement in the formation of nonwovens on the other hand, it was surprisingly established in conjunction with the application of high working medium pressures that hydrodynamic stitch-bonding of metal fiber nonwovens using high-energy water jets can be carried out using the known spunlace method.

According to the invention, the object is solved by achieving high impact forces or impulse forces by using working

medium pressures >200 bar or by using special nozzle geometries (e.g. cylindrical, conical, double-cone, cylindrical and conical combined in different ratios), using bore diameters, for example, between 0.08 and 0.5 mm, selecting a number of nozzles per inch of working width according to the intended use, using at least 2 to 8 nozzle beams, using single- to four-row nozzle beams in a uniform or nonuniform arrangement of capillaries applying the stitch-bonding medium from both sides, e.g. alternately after each nozzle beam or only after passing a plurality of nozzle beams, using a carrier belt or an open-work drum having an open area of 20 to 50%- or a screen covering or 20 to 100 mesh, preferably 60 mesh for removing the stitch-bonding medium.

A thin, a closed or spunlace nonwoven having an open-work surface according to a pattern, also comprising 100% metal fibers, is provided according to the invention without textile carrier fibers being required during its manufacture, laborious and time-consuming thread formation being required, lubrication being required to avoid static charging and to ensure good fiber sliding properties between fiber/fiber, fiber/stitch-bonding elements and fiber/transport units, and without any wear to the stitch-bonding elements since water is used as the stitch-bonding agent.

However, the joint use of non-metallic textile fiber materials is possible without any problems from the purely technical point of view. It is therefore also consistent with the inventive idea that if special product properties are required, textile fibers can be used in any mixing ratio.

The invention is explained in detail in exemplary embodiments.

Example 1:

A 300 g/m^2 heavy, aerodynamically formed nonwoven consisting of 100% metal fibers is supplied to the spunlace installation. The normal density of the alloy of the metal fibers was determined as 8 g/cm^3. The 12µm thick stainless fibers in this case consist of a chromium-iron alloy. The metal fiber nonwoven is stitch-bonded using high-energy water jets. The water emerges from a nozzle sheet comprising nozzles having a diameter of 0.14 mm arranged in a row, in a capillary density of 40 items/inch of working width and at a process water pressure of 20 bar on the first nozzle beam and 300 bar on the second nozzle beam. These stitch-bonding parameters yield maximum tensile forces of 19 N in the longitudinal direction and 26 N in the transverse direction with maximum elongations under tensile force of 34% in the longitudinal direction and 53% in the transverse direction.

Example 2:

The arrangement and the type of nonwoven corresponds to those of Example 1. In contrast to Example 1, nozzle sheets comprising nozzles of 0.10 mm diameter and 40 items/inch of working width are used. The stitch-bonding medium is at a working pressure of 20 to 400 bar. The metal fiber nonwoven stitch-bonded under these parameters has maximum tensile forces of 24 N in the longitudinal direction and 32 N in the transverse direction with maximum elongations under tensile force of 31% in the longitudinal direction and 33% in the transverse direction.

Example 3:

The arrangement and the type of nonwoven corresponds to those of Example 2. In contrast to Example 2, 36 nozzles per inch of working width are used. The maximum tensile forces are 42 N in the longitudinal direction and 49 N in the transverse direction with maximum elongations under tensile force of 37% in the longitudinal direction and 43% in the transverse direction.

The spunlace nonwoven in this example has completely identical stress-strain values for the longitudinal and transverse directions in the initial and medium stressing range, i.e., it is absolutely isotropic over this range. Likewise, the porosity of the metal fiber nonwoven can be adjusted over a wide range by selecting the stitch-bonding parameters. The pore volume is 97-99%. However a pore volume of 60 to 99% can also be achieved according to process data.

Example 4:

The arrangement and the type of nonwoven corresponds to those of Example 3. In contrast to Example 2, three nozzle sheets in corresponding nozzle beams are used at a working medium pressure of 20/500/500 bar. The maximum tensile forces are 89 N in the longitudinal direction and 78 N in the transverse direction with maximum elongations under tensile force of 29% in the longitudinal direction and 34% in the transverse direction. With this example it can be shown that a higher strength can be achieved in the longitudinal direction than in the transverse direction.

Example 5:

The arrangement and the type of nonwoven corresponds to those of Example 3. In contrast to Example 3, the stitch-bonding process by high-energy water jets is followed by a pressing or calibrating process. The strength and the porosity of the metal fiber nonwoven can be thereby influenced in addition to the stitch-bonding by means of water jets.

These examples show that the maximum tensile force in the longitudinal direction (HZKL) and in the transverse direction (HZKQ) can be specifically controlled and the ratio of maximum longitudinal tensile force to maximum transverse tensile force can be adjusted from >1 through =1 to <1. It is of major importance that the stress-strain behavior in the initial and medium stressing range can be configured as completely isotropic by using selected stitch-bonding parameters. Equally, it is possible to adjust the porosity of the metal fiber nonwoven over a wide range.

Example 6:

The metal fiber nonwoven to be stitch-bonded is subjected to a spunlace treatment using 36 nozzles per inch of working width having a diameter of 0.10 mm, an underlay screen of 20 mesh fineness and a working medium pressure of 500 bar and perforated according to a pattern for use as a burner surface or the like.

Example 7:

A metal wire mesh positioned between two metal fiber nonwovens having a mesh width of 10 x 10 mm, for example, is subjected to a spunlace treatment using 36 nozzles per inch of working width having a diameter of 0.10 mm, an underlay screen of 60 mesh and a working medium pressure of 500 bar. In this case,

the nonwoven is stitch-bonded to give a smooth surface with small pore openings whilst at the same time accommodating the metal mesh. Such metal composites are used for filtering tasks where a high thermal loading occurs. In this case, the stitch-bonded metal fiber nonwoven is intended to fulfil the filtering tasks and the metal mesh fulfils the function of strength carrier.

Nonwovens having a thickness between 1.5 and 3.4 mm were prepared in the experiments. The gross density was about 8 mm_ The density of the spunlace nonwovens was between 0.1 and 0.2 g/cm^3. The attainable porosity is between 60 and 99%.

The nonwovens described can be used in filter and burner technology, especially where high thermal loads occur, in the EMC area, to achieve protection from explosions etc.